Need for A Persistent Platform

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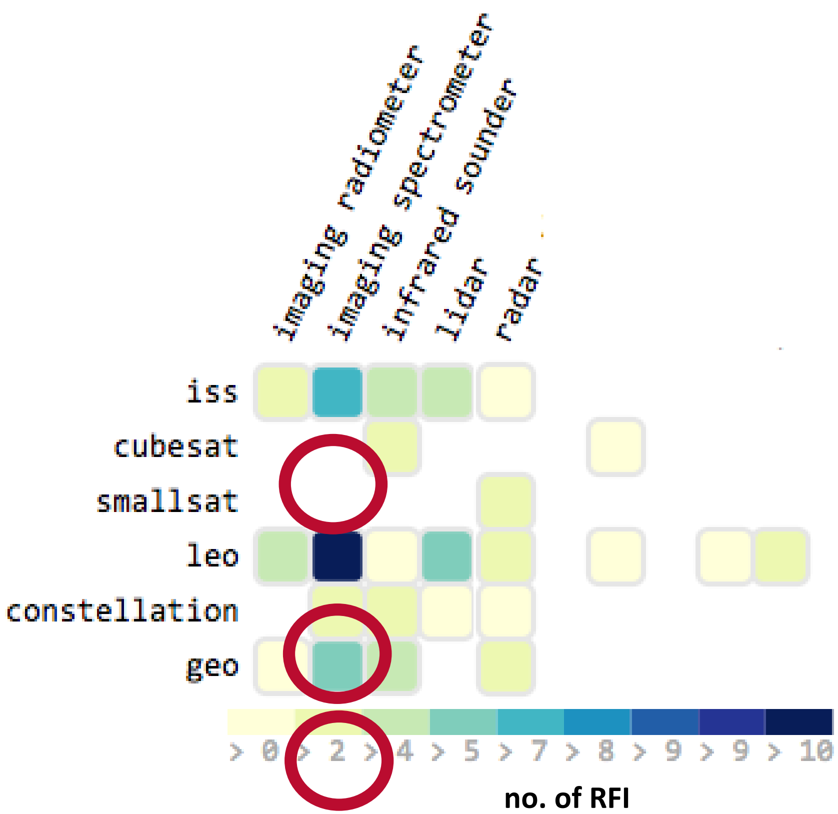
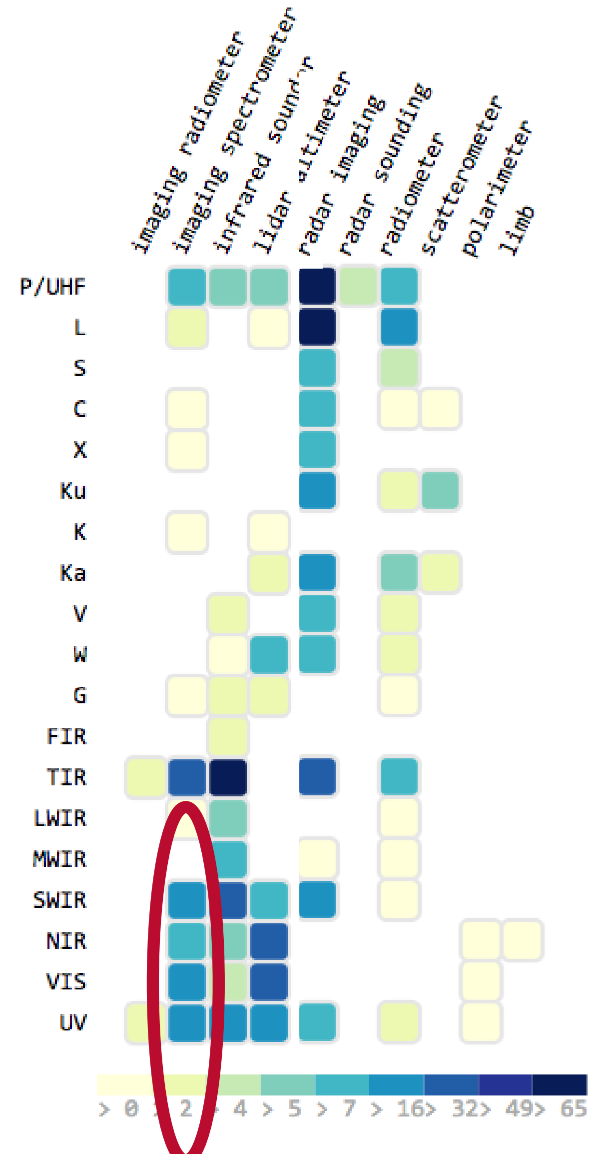
Outline

- Based on the current Decadal survey RFI responses, coincidental measurements and higher temporal sampling are necessary for advancing Earth system science.
- In order to implement the observing architecture affordably, Science Station becomes one of the key platform to provide a hosting capability.
- SSL has been advancing technologies through government programs and poise to launch the first platform by 2020 if there is a commitment from customers for occupying the spaces.
- In next 3 years, we would like a direction from NASA/NOAA/DoD on instrument hosting, technology demo at RESTORE-L, and inter-government coordination

Summary of analysis

There were 145 RFI responses and each document had numerous measurement and Instruments listed with different orbits. This method can summarize key parameters in representative relationships.



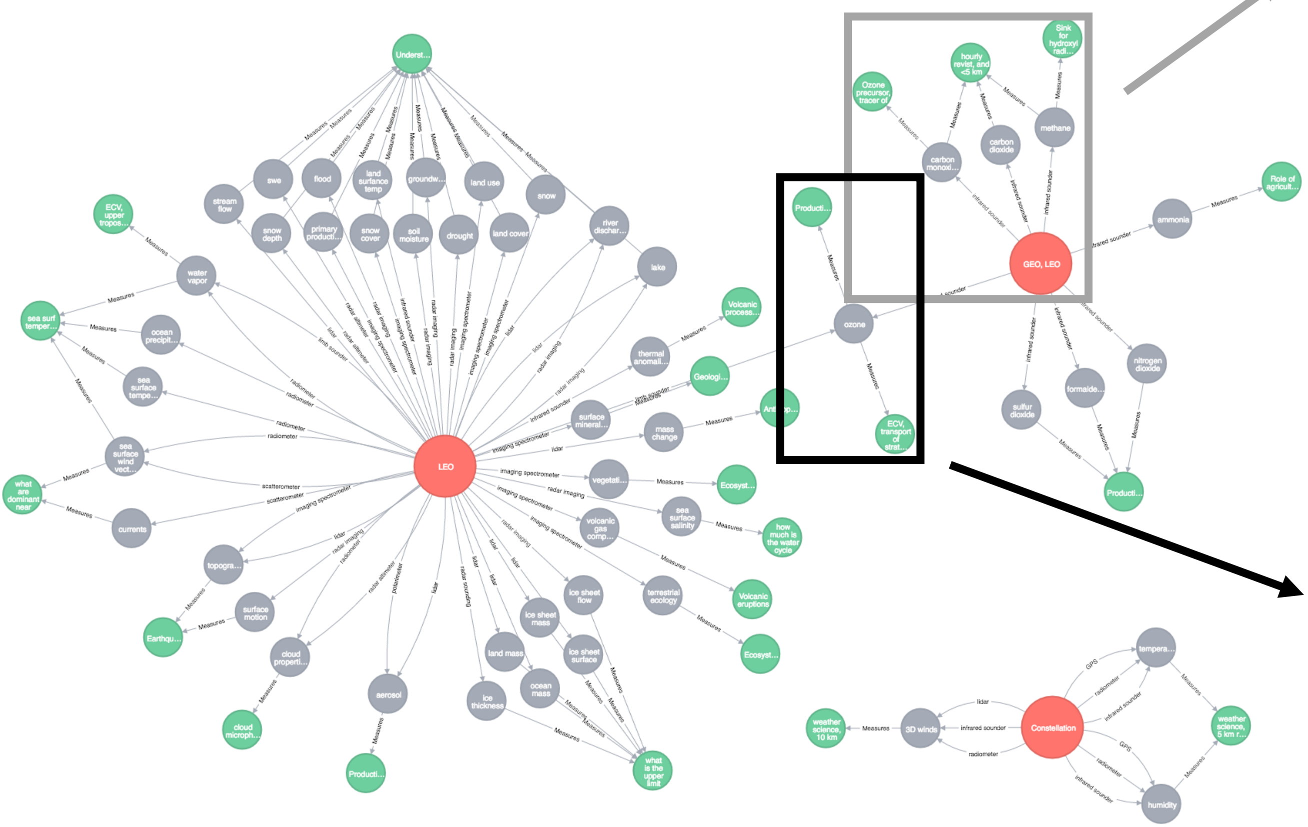


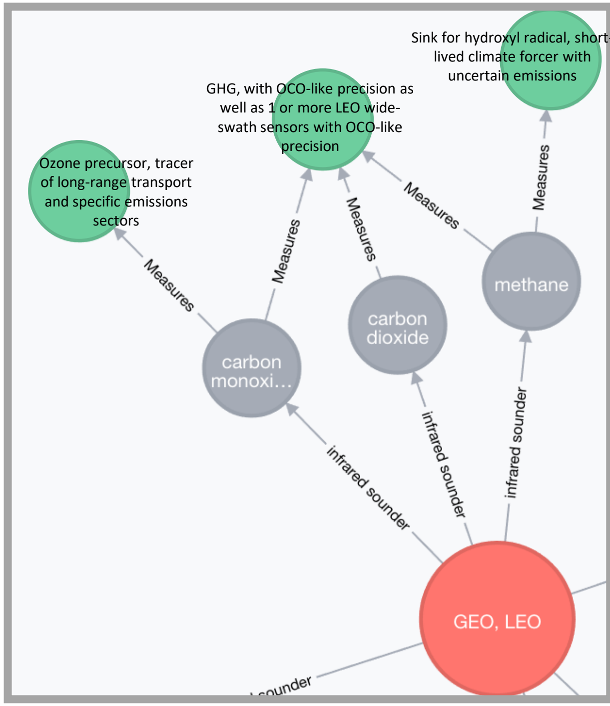
Analytics for **Deeper Insights** from DS RFI

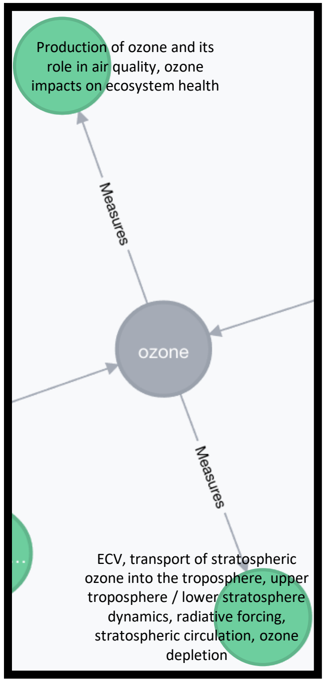
Network representations illustrate the **relationships** between variables like orbit, instruments, measurements, and science questions

Highlighted areas show where **single measurements** can answer **multiple science questions**

Orbit	Science Question	Measurement
LEO	16	38
GEO + LEO	6	8
Constellation	2	3



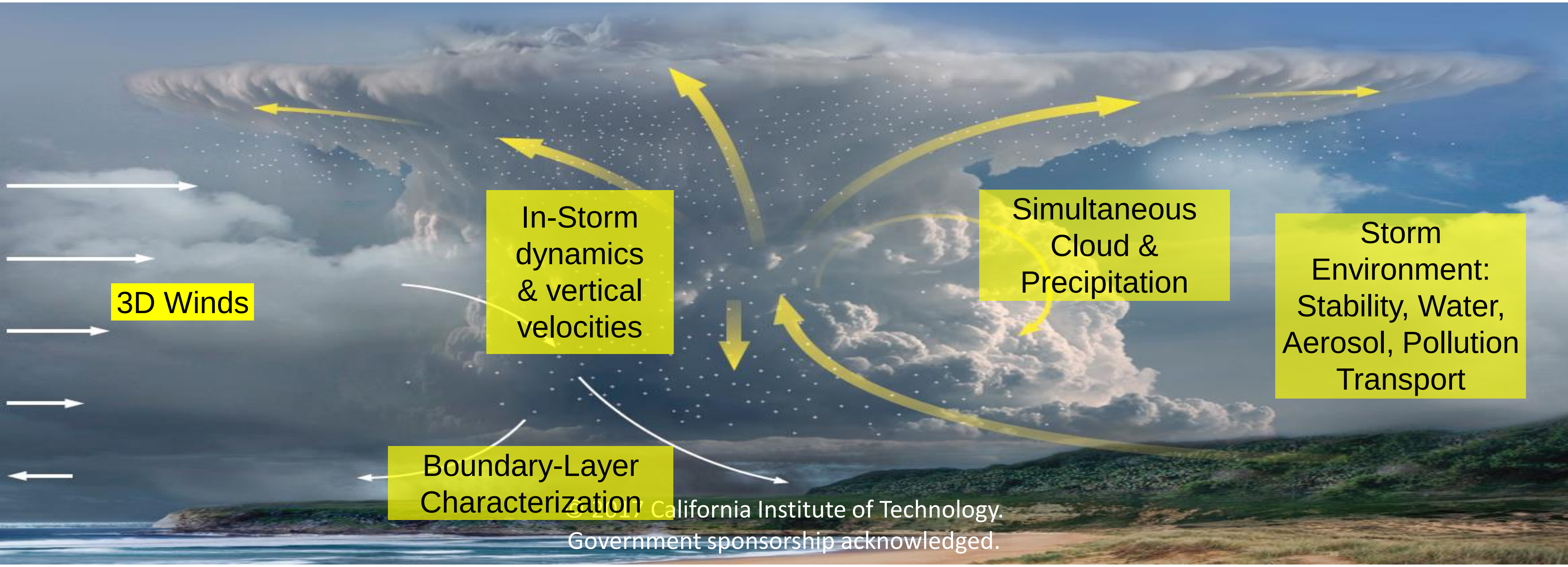




Complexity of Understanding Weather Science – Need for multiple measurements

- Constellations or GEO to monitor **storm evolution**
- Higher spatial resolutions to capture **mesoscale structure**
- Capture **microphysical processes** key to precipitation growth
- Advancing technology to characterize the atmospheric **boundary-layer**
- Improved atmospheric profiling to characterize the **storm environment**
- Characterizing storm dynamics and extremes with **Doppler radar**
- **Miniaturization** of sensors for **cubesats**, constellations and lower costs

>=3 flagship missions in order to provide all measurements



EDR (Transition from NASA to NOAA)

Legend: X

- Green = EDR is provided by EOS
- Light green = EDR reliant on foreign partner
- Yellow = EDR is partially provided
- Black = No space-based capability
- Light blue = EDR relies on FOO
- Brown = EDR is modeled, not sensed
- Dark blue = EDR provided by NPOESS
- Med blue = EDR provided by NPP

Assumptions:

Terra launched Dec 99, EDRs available in 2000
ICESat only delivered EDRs for short period
Terra, Aqua, Chem will last 6 years
NPOESS C1 carries VIIRS, CMIS, APS, and Landsat Follow-on
NPOESS C2 (2011) carries VIIRS, CMIS, CrIS, ATMS, OMPS, ERBS
NPOESS C3 (2013) carries VIIRS, CMIS, CrIS, ATMS, TSIS, ALT
NPOESS C4, C5 & C6 extend the full capability at least to 2020
NPP launches Oct 06, EDRs available in 2007 (carries VIIRS, CrIS, OMPS, ATMS)
NPOESS C1 launches late 2009, EDRs available in 2010

*Fires is not an official VIIRS EDR

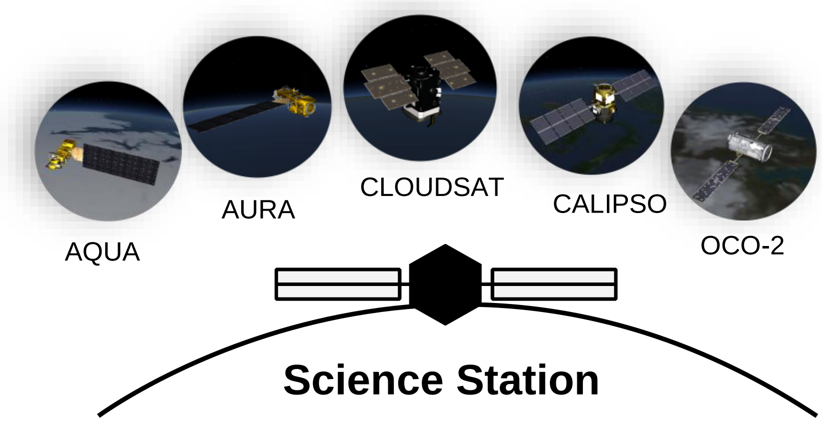
Earth Science Trends

Individual
Science Results

Actionable Information
- Stakeholder engagement
- Model development
- Processing and assimilation of large volumes of disparate data
- Quantification of uncertainties for individual data sets and final products
- Measurement Continuity

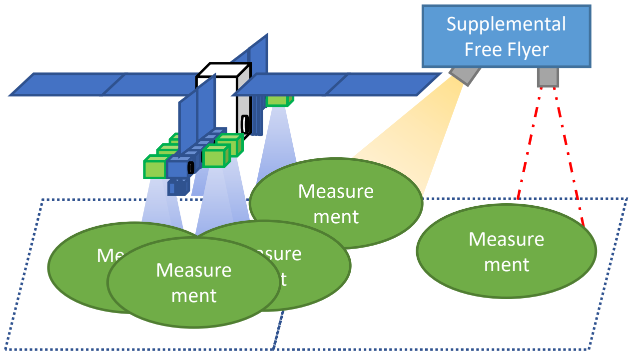
Sparse,
Uncoordinated
LEO satellites

Coordinated observatories with high spatial and temporal sampling
Industry partnership and leadership



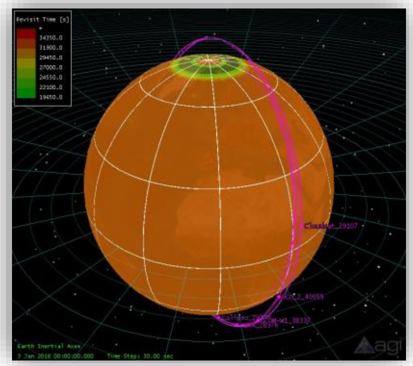
Constellations

Persistent Platform – Science Station (PP-SS) Concept

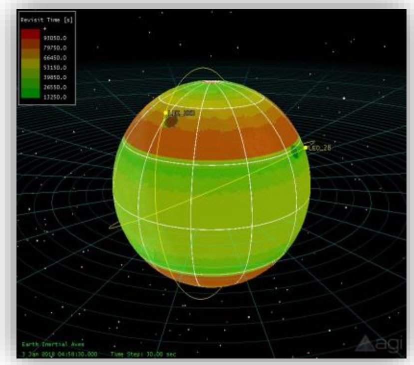


IS3 architecture can exploit coincident overlap and be supplemented with free flyers to cooperatively answer multiple questions

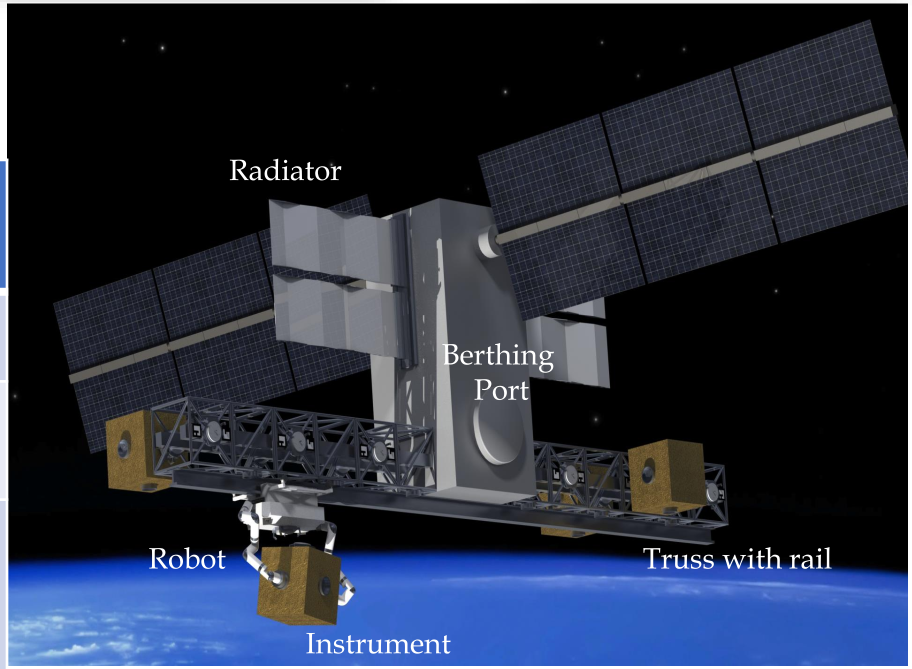
A-train revisit period and temporal coverage data averaged over 3-month span (10 hours)



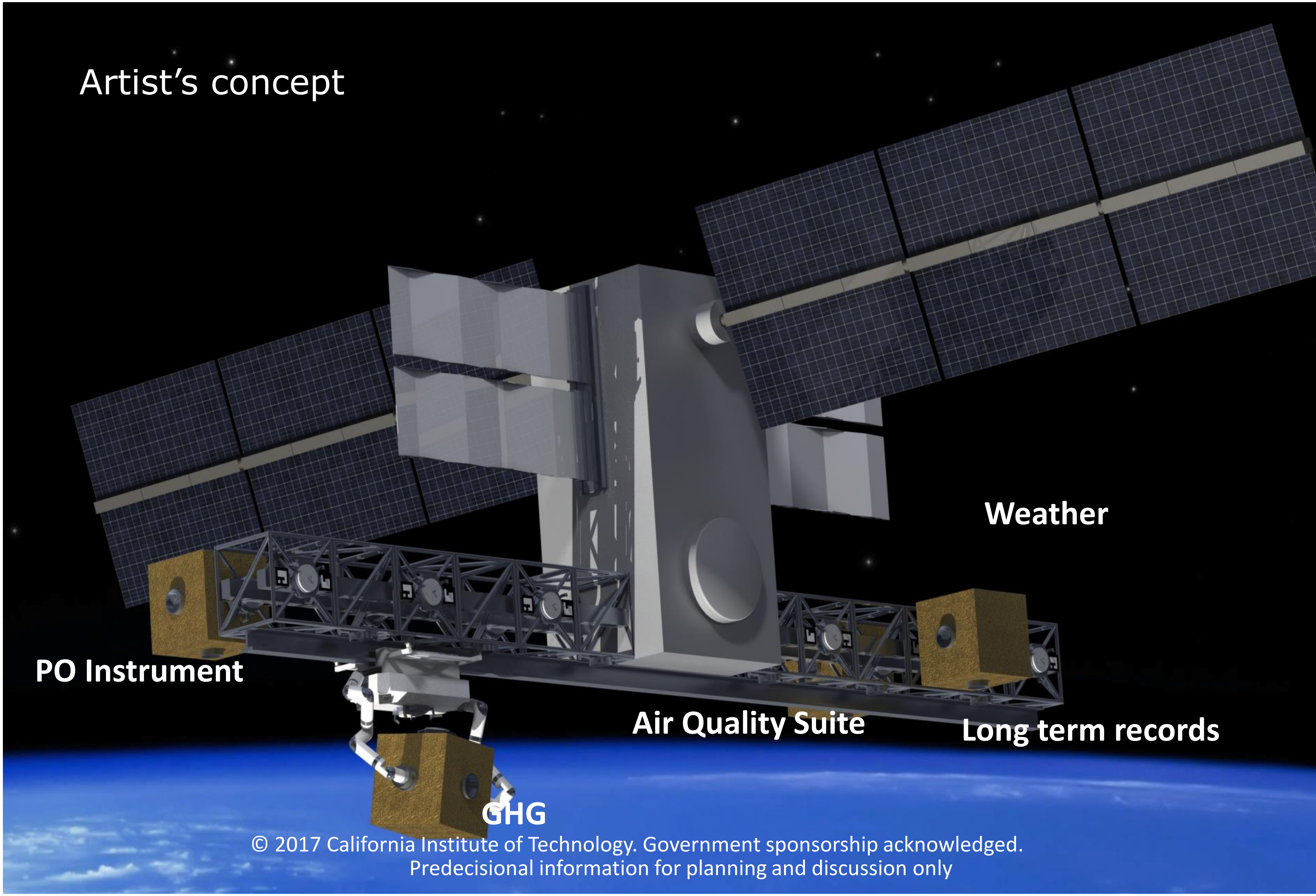
Dual SSO/LEO IS3 revisit period and temporal coverage data averaged over 3-month span (3 hours)



Trade Space	Science Station (Hosted payload)	OneWeb/Skybox (Constellation/smallsat)
Duration/cost	5 – 20 years $5-10M/year + ESPA	5 years $5 -10M + Launch
Observing Scenario	Coincident measurements Replaceable/serviceable	High temporal revisits
Instrument characteristics	High power/larger aperture (1 KW, 1 m volume, 500kg)	< 60 kg, > 0.15 deg pointing control



Science Station Concept - Polar



Description of PP-SS Concept

- PP-SS will eliminate spacecraft and launch cost significantly as evidenced by ISS EV-I
  - The most of instruments in A Train could be hosted on such a platform
    - Up to 12 instruments could be built by 2025 ($100 - 200M per instrument)
  - No need to provide dedicated power, downlink, propulsion, attitude systems. The station handles all this.
  - Dedicated downlink, small launches, ease of tracking a single object reduces overall cost for supporting services
  - Modular architecture is more robust to failure of individual instrument modules
  - Cost analysis show a significant saving ($5 – 10M/year/instrument for hosting - projected)
    - No upfront cost of satellite or dedicated launch vehicle
    - Savings up to $500M per mission
    - Added benefit of enabling coincidental measurements
- Platform Specification
  - Robotically Serviceable GEO communication satellite based platform at LEO and GEO
  - 15 – 25 year life with today's technology
  - RESTORE-L will be the first demo mission in 2020; PP-SS launch in 2022
  - Only pay for the lease of hosted payloads
  - 1 Sun synchronous and 1 ISS-like inclined platform can provide daily coverage of Earth
  - Industry will provide the platform
    - Many platforms will be built to host civil, DoD, and commercial customers

Proposed Instrument Interface Design

Active Pointing

Allows fine pointing adjustments to achieve accuracy requirements.

Electronics/Computers

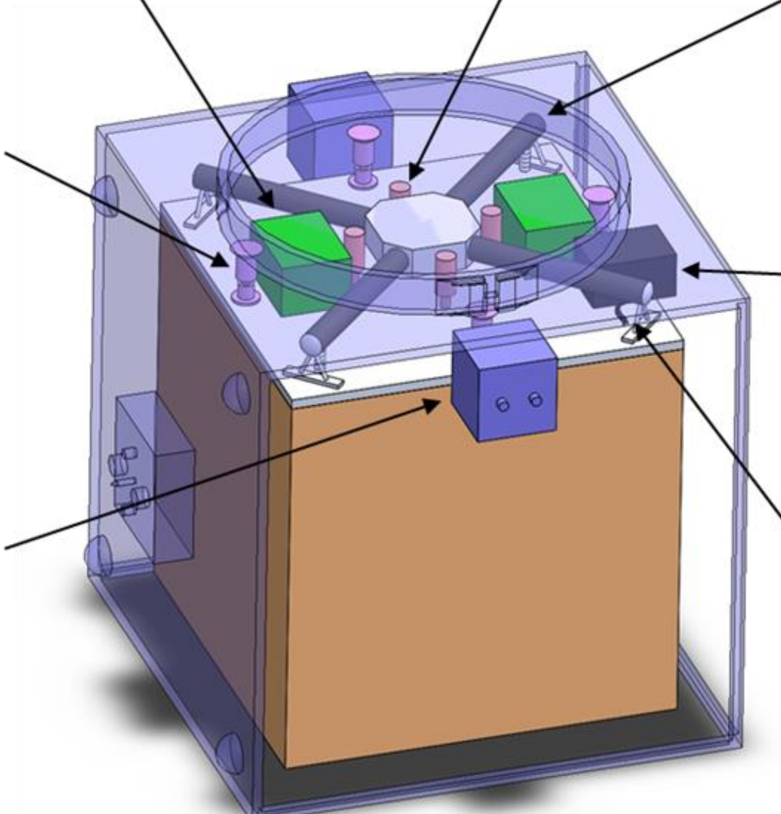
Processing for star tracker/active pointing, power and data management.

Passive Isolation System (JWST Concept)

Prevents transmission of jitter and disturbances between the instrument and the truss.

Launch Locks

Rigidly connects pallet and instrument during launch.



Star Tracker

Provides absolute knowledge of instrument position and orientation.

Robot Grapple Interface

Physical, electrical, and data connection to robot.

Flexible Harnessing

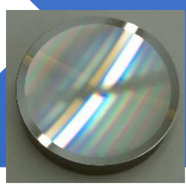
Flat cables and bellows reduce the transmission of vibrations.

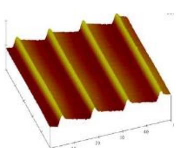
Next Generation Technology at JPL Enables Miniaturized Instruments

Visible

Miniature Dyson spectrometer

JPL e-beam grating

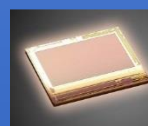




Infrared

JPL IR&D Wide-Field Grating Spectrometer (WFGS)

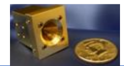
JPL BIRD MWIR Detectors



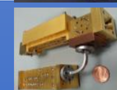
JPL Qualified Thales Cooler

Microwave

Dual-Frequency Feedhorn



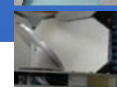
MMIC Receiver including Detector



Radiometer Backend and Power Conditioning

Motor and Drive Electronics

Reflector

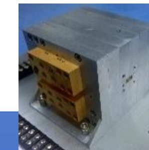


Command and Data Handling: Onboard FPGA

MASC

Radar

SSPA & Power Combiner



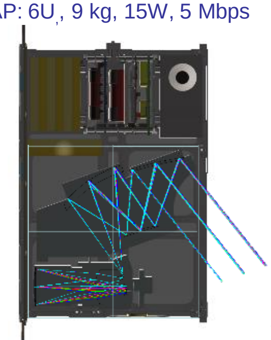
Up/Down Converter

Processing (Pulse Compression and Modulation)

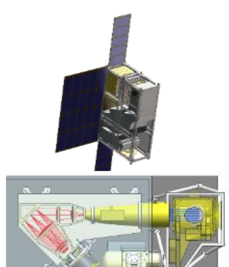
Gravity

MicroGRACE Gravity Measurement
Spatial: 300 km (Horiz) x 300 km(Vert)
SWAP: 6U, 20 kg, 30 W, 4.4 Kbps

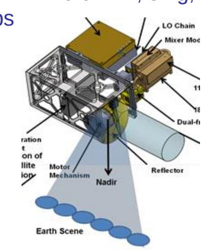
Snow and Water Imaging Spectrometer
Spatial: ±5°, 0.28 km
Spectral: 228 Bands, 350 nm – 1.65 µm
SWAP: 6U, 9 kg, 15W, 5 Mbps



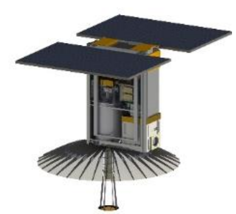
CubeSat Infrared Atmospheric Sounder (CIRAS)
Spatial: ±48.3°, 13.5 km
Spectral: 1000 Channels, 4.1-5.4 µm
SWAP: 6U, 20 kg, 30 W, 1 Mbps

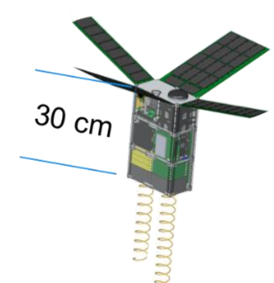


Microwave Atmospheric Sounder on CubeSat (MASC)
Spatial: ±45°, 15 km (183) – 20 km (118)
Spectral: 8 Channels: 118-183 GHz
SWAP: <0.01 m^3, 3 kg, 7 W, 10 kbps



RaInCube: Precipitation Profiler
Spatial: 5 km (Horiz) x 250m (Vert)
Spectral: 35.6 GHz
SWAP: 6U, 20 kg, 30 W, <1 Mbps



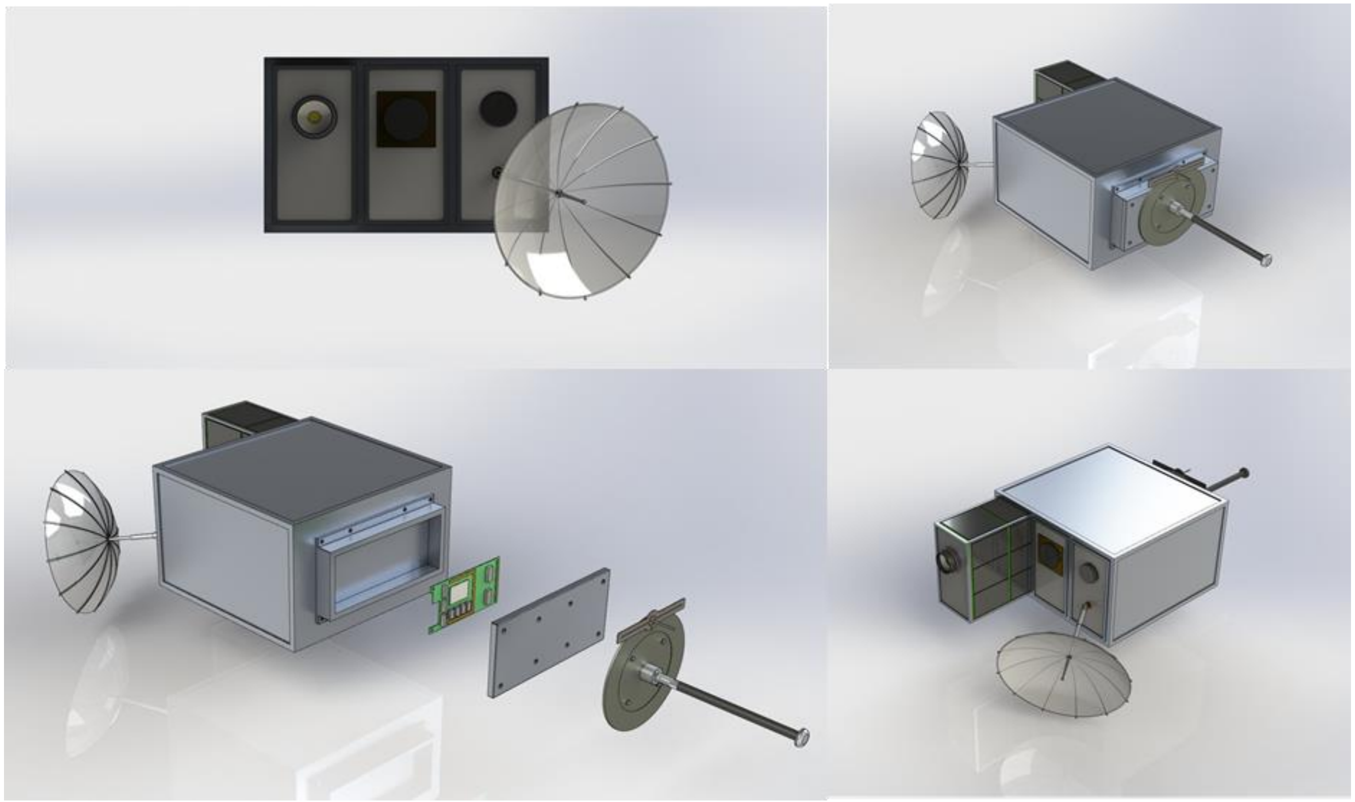


Total Identified Here: 72kg, 112W, 8 Mbps

Proposed Earth Science 2.0

Interface to Payloads

Interface to platform



Autonomous Planning and Execution

Instrument control, event detection, onboard science and planning

Mass producibility

Predecisional information for planning and discussion only

Summary

- CII could lead the definition for the interface
  - Coordinate with industry to develop this capability
  - JPL would prototype and transition it to industry
  - Consider this platform for EV-I and EV-M
- A workshop with ESSP and ISS
- Testbed development for compatibility testing
- Communicate with other parts of NASA and government
  - microgravity lab, space manufacturing, technology demo, Mars infrastructure, DoD assets